



Logic, Information flow and Argumentation

**Homework exercises, Week 3, part b (due Tuesday 29 February).**

1. Use the *tableau* method to check whether the following formulas are *tautologies*.
  - (a)  $\neg\neg p$
  - (b)  $p \rightarrow (q \rightarrow r)$
  - (c)  $(p \rightarrow (q \rightarrow r)) \rightarrow ((p \rightarrow q) \rightarrow (p \rightarrow r))$
  - (d)  $((p \vee q) \vee \neg(p \vee (q \wedge r)))$
  - (e)  $(p \rightarrow (q \wedge r)) \leftrightarrow ((p \rightarrow q) \wedge (p \rightarrow r))$
2. Use the *tableau* method to check whether the following formulas are *contradictions*.
  - (a)  $(p \vee q) \wedge (p \vee \neg q)$
  - (b)  $\neg((p \rightarrow q) \vee (q \rightarrow p))$
  - (c)  $(p \rightarrow q) \wedge (p \rightarrow \neg q)$
  - (d)  $(\neg(p \vee q)) \wedge \neg(\neg p \wedge \neg q)$
  - (e)  $((p \rightarrow q) \wedge (q \rightarrow r)) \wedge (r \rightarrow \neg p)$
3. Use the *tableau* method to check whether the formulas from Exercise 2 above are *satisfiable*.
4. Use the *tableau* method to check whether the following are valid inferences:
  - (a)  $p \vee q, \neg q \models p$
  - (b)  $p \rightarrow q \models q \rightarrow p$
  - (c)  $p \wedge \neg p \models q$
  - (d)  $p \rightarrow q, p \models q$
  - (e)  $(p \vee q) \wedge r \models p \vee (q \wedge r)$

- (f)  $p \vee (q \wedge r) \models (p \vee q) \wedge r$
- (g)  $p \rightarrow q \models (\neg p) \vee q$
- (h)  $\neg(p \wedge q) \models \neg p$
- (i)  $((\neg p \vee \neg q) \vee r), (q \vee r), p \models r$
- (j)  $\neg(p \rightarrow (q \wedge r)), r \rightarrow (p \wedge q) \models \neg r$
- (k)  $p \rightarrow (q \wedge r), \neg((p \vee q) \rightarrow r) \models p$
- (l)  $p \rightarrow q, p \rightarrow r \models q \leftrightarrow r$